

Claims

1. A method of determining which pin locations in a printhead of a microarray spotting instrument are occupied by pins, comprising:
providing a pin detection apparatus; and
using the pin detection apparatus to automatically detect whether a pin is present in given pin locations.
2. The method of Claim 1 wherein said pin detection apparatus comprises a sensor to sense whether a pin is present in a given pin location.
3. The method of Claim 2 wherein said sensor comprises a contact and circuitry for detecting electrical conduction between said contact and said pin.
4. The method of Claim 3 wherein said contact comprises a probe hole in a printed circuit board.
5. The method of Claim 3 wherein said contact is compliant.
6. The method of Claim 5 wherein said contact is spring-mounted.
7. The method of Claim 5 wherein said contact comprises a conductive rubber pad.
8. The method of Claim 2 wherein said sensor senses the presence of the pinhead of the pin.
9. The method of Claim 2 wherein said sensor senses the presence of a tip of the pin.
10. The method of Claim 2 wherein said sensor comprises a strain gage sensor.
11. The method of Claim 2 wherein said sensor comprises a piezoelectric sensor element.
12. The method of Claim 2 wherein said sensor comprises a micro-switch.
13. The method of Claim 2 wherein said sensor comprises a capacitive sensor.
14. The method of Claim 2 wherein said sensor comprises an inductive sensor.
15. The method of Claim 14 wherein said inductive sensor comprises an air-core coil

inductor including a hole for receiving at least a portion of a pin.

16. The method of Claim 14 wherein said inductive sensor comprises a pair of spaced apart, but proximate coils each adapted for receiving a portion of a pin.

17. The method of Claim 2 wherein said sensor comprises an optical sensor.

18. The method of Claim 1 wherein said pin detection apparatus comprises a plate with a hole, and wherein using said pin detection apparatus comprises:

applying a vacuum to said hole;

positioning said printhead relative to said plate such that if a pin were located in a given pin location of said printhead, said pin would be inserted in said hole; and

sensing any pressure changes in said hole.

19. The method of Claim 1 wherein said pin detection apparatus comprises a surface with a step, and wherein using said apparatus comprises:

positioning said printhead relative to said step such that a given pin location is positioned above said step and if a pin were located in said given pin location, said pin would be supported by said step and a pinhead of said pin would be raised relative to the printhead; and

sensing any pinhead raised relative to said printhead.

20. The method of Claim 1 wherein said pin detection apparatus includes an array of sensor elements corresponding in arrangement to said pin locations in said printhead for simultaneously detecting the presence of pins in each pin location.

21. The method of Claim 1 wherein said pins comprise solid pins.

22. The method of Claim 1 wherein said pins comprise split pins.

23. The method of Claim 1 wherein said pins comprise tubular pins.

24. The method of Claim 1 further comprising using the pin detection apparatus to

automatically detect whether a pin is stuck in a raised position in the printhead.

25. An apparatus for determining which pin locations in a printhead of a microarray spotting instrument are occupied by pins, comprising at least one sensor element to automatically detect whether a pin is present in each said pin location.

26. The apparatus of Claim 25 wherein said at least one sensor element comprises a contact and circuitry for detecting electrical conduction between said contact and said pin.

27. The apparatus of Claim 26 wherein said contact comprises a probe hole in a printed circuit board.

28. The apparatus of Claim 26 wherein said contact is compliant.

29. The apparatus of Claim 26 wherein said contact is spring-mounted.

30. The apparatus of Claim 26 wherein said contact comprises a conductive rubber pad.

31. The apparatus of Claim 25 wherein said at least one sensor element senses the presence of the pinhead of the pin.

32. The apparatus of Claim 25 wherein said at least one sensor element senses the presence of a tip of the pin.

33. The apparatus of Claim 25 wherein said at least one sensor element comprises a strain gage sensor.

34. The apparatus of Claim 25 wherein said at least one sensor element comprises a piezoelectric sensor element.

35. The apparatus of Claim 25 wherein said at least one sensor element comprises a micro-switch.

36. The apparatus of Claim 25 wherein said at least one sensor element comprises a

capacitive sensor.

37. The apparatus of Claim 25 wherein said at least one sensor element comprises an inductive sensor.
38. The apparatus of Claim 37 wherein said inductive sensor comprises an air-core coil inductor including a hole for receiving at least a portion of a pin.
39. The apparatus of Claim 37 wherein said inductive sensor comprises a pair of spaced apart, but proximate coils each adapted for receiving a portion of a pin.
40. The apparatus of Claim 25 wherein said at least one sensor element comprises an optical sensor.
41. The apparatus of Claim 25 wherein said at least one sensor element comprises a vacuum sensor including a plate with a hole, means for applying a vacuum to said hole, and a pressure transducer at said hole for sensing pressure changes at said hole from placing a pin in said hole.
42. The apparatus of Claim 25 wherein said at least one sensor element comprises a surface with a step and a sensor for detecting a raised pinhead of a pin in the printhead when the printhead is positioned relative to said step such that said pin is supported by said step.
43. The apparatus of Claim 25 wherein said at least one sensor element comprises an array of sensor elements corresponding in arrangement to said pin locations in said printhead for simultaneously detecting the absence or presence of pins in each pin location.
44. The apparatus of Claim 25 wherein said pins comprise solid pins.
45. The apparatus of Claim 25 wherein said pins comprise split pins.
46. The apparatus of Claim 25 wherein said pins comprise tubular pins.
47. The apparatus of Claim 25 wherein said at least one sensor element also automatically

detects whether a pin is stuck in a raised position in the printhead.

48. A microarray spotting instrument comprising:

- a printhead for holding a plurality of pins;
- a substrate station for holding at least one microarray substrate;
- a well station for holding sample material to be deposited on said at least one microarray substrate using said printhead;
- a positioning mechanism for moving said printhead;
- a controller for controlling movement of said printhead; and
- a pin detection apparatus for automatically detecting the absence or presence of pins in one or more pin locations in said printhead.

49. In a microarray spotting instrument, a method of providing to a controller operating the instrument information on which pin locations in a printhead in the instrument are occupied by pins, comprising:

- automatically sensing whether a pin is present in a pin location and generating a signal indicative thereof; and
- transmitting the signal to the controller.

50. A method of determining whether a pin in a printhead of a microarray spotting instrument is stuck in a raised position, comprising:

- dipping tips of pins mounted in the pinhead into a reservoir of target material;
- positioning the printhead over a microarray substrate to be spotted;
- lowering the printhead to bring the tips of the pins into contact with the substrate to print spots on the substrate and, in the process, moving the pins in the printhead into raised positions relative to the printhead;
- raising the printhead to separate the pins from the substrate; and
- using a pin detection apparatus to automatically detect whether a pin in the printhead is stuck in a raised position.

51. The method of Claim 50 further comprising stopping operation of the spotting instrument

when a pin is detected to be stuck in a raised position.

52. The method of Claim 50 further comprising issuing an alert when a pin is detected to be stuck in a raised position.

53. The method of Claim 50 further comprising reconfiguring an instrument control sequence to avoid using a pin detected to be stuck in a raised position.